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ONTARIO

DEPARTMENT OF EDUCATION

BIOLOGY

SENIOR DIVISION
GRADE 13

Replacing Curriculum S. 23 Biology

For introduction in September, 1965

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THE MINISTER OF EDUCATION

Ministry of Education, Ontario
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BIOLOGY

Grade 13

There are two main objectives in teaching Biology in Grade 13:

(1) to provide some general knowledge for those who will not study this subject further and,

(2) to provide a good foundation for those who will proceed to advanced work.

The topics of this course have been arranged in an order that makes possible the identification and study of the factors that are common to plant and animal life: the unit cell, the assimilation of food materials, the various physiological processes, the principles of heredity. This approach emphasizes the concepts of the dependence of animal life on plant life, and the interdependence of all forms of life.

Related species not included for special study should be brought to the attention of pupils when they are of special local significance or interest.

Systematic notebook records and observational drawings or diagrams are essential.

The number of periods indicated (each of approximately 35 to 40 minutes), is merely a suggestion or a guide to the depth of treatment.

OUTLINE – BIOLOGY 13

Unit I. CHARACTERISTICS OF LIVING THINGS (5 periods)

This unit is intended to organize the previously-acquired knowledge of plants and animals to focus attention on those characteristics which make them living things.

1. **Movements in Animals and Plants**

   Muscular movement (with skeletal supports)—mammal, bird, reptile, frog, fish, crayfish, insect

   Muscular movement (no skeletal support) — earthworm, hydra, octopus

   Ciliate and flagellate movement — as in paramoecium, chlamydomonas, bacteria

   Movements in higher plants — closing of leaves and flowers, growth movements

   Distinction between locomotion, and motion, as in eyelid, eye, tongue, heart

2. **Irritability**

   Nature of stimuli — light, moisture, gravity, heat, cold, sound, touch, chemical substances

   Special receptors for stimuli — e.g., eye, ear, hot and cold receptors, pressure receptors, taste organs, in which information from the environment prompts reaction through some form of conducting system

   Organisms without special sense organs are also irritable, e.g., plants, amoeba, paramoecium

3. **Reproduction:** Capacity for reproducing their kind

   (i) Asexual — vegetative or fission — e.g., hydra, plant bulbs, plant cuttings, amoeba, bacteria, chlamydomonas
   — spore formation — e.g., mushrooms, mosses, ferns

   (ii) Sexual — fusion of gametes to produce a zygote from which the organism develops by growth, division and differentiation of cells in both plants and animals

4. **Metabolism**

A general review of anabolism and catabolism and the processes involved, namely, photosynthesis, digestion (extracellular, intracellular), assimilation, respiration, excretion

Unit II. **CELLS** (35 periods)

This unit emphasizes that the basic unit of life is the cell (just as the atom is the basic unit of matter), and that the living protoplasm in all plant and animal cells has similar physical and chemical properties, and that cells are produced from pre-existing cells.

1. **Structure of Cells**

Microscopic examination and electron photomicrographs of plant and animal cells to permit discussion of component structures: nucleus, nucleoli, cytoplasm, mitochondria, ribosomes, lysosomes, endoplasmic reticulum, golgi body, ground substance, membranes, cell wall and pits, centrioles, vacuoles, plastids, starch bodies, fat bodies, protein bodies

2. **Composition of Protoplasm**

Review of chemical background: atoms, molecules, chemical bonds, chemical reactions and energy changes associated with them, ionization, equilibrium reactions, catalysts

Organic molecules: carbohydrates, fats, proteins, nucleic acids, and nucleoproteins (stress of the general structure of the molecules indicating important linkages — no formulas required for examination purposes)

3. **Physical Properties of Protoplasm**

Include colloids, sol-gel changes, protoplasmic movements

4. **Catabolism** (no formulas required for examination purposes)

(a) Digestion: hydrolysis of carbohydrates, fats, and proteins to produce simpler soluble substances (treatment as an essential preliminary to respiration)

(b) Respiration: the oxidation of the glucose molecule to carbon dioxide and water with energy made available in the reactions; transfer of energy via the ADP-ATP system; oxidation of fats and proteins; metabolic role of vitamins and minerals; simple treatment of energy transformations to do work; efficiency of energy transfers and transformations; role of mitochondria

5. **Anabolism** (no formulas required for examination purposes)

   (a) Photosynthesis: energized chlorophyll; transfer of energy to the ADP-ATP system and photolysis of water; the formation of hydrocarbons and the concept of available potential energy in the molecules; role of chloroplasts

   (b) Syntheses other than photosynthesis in animals and plants, e.g., cellulose, glycogen, fats, proteins

6. **Functions of Cell Membranes**

   Osmosis: cell turgor; permeability to substances other than water; active transport and its dependence on metabolic energy. Importance of cell environment; composition of environment; limits of tolerance to changes in medium of cells; osmotic value; wilting; plasmolysis

   Experiments to demonstrate osmosis and plasmolysis

7. Mitosis; chromosomes, genes, D.N.A., R.N.A., enzyme synthesis, regulation of metabolism, growth and development of cells, cell theory

   Mechanism of virus action

   Factors influencing the size of cells (including metabolic rate, polyploidy, diffusion)

Unit III. **ORGANISMS** (55 periods)

This unit deals with two complex multicellular organisms showing that there are similar essential activities in plants and animals and that by the specialization of cells into tissues and organs, the various gross functions are carried on in each organism.

1. Organization of cells into tissues, tissues into organs, organs into organ systems, organ systems into organisms

2. **Dissection and Study of a Mammal**

An examination of organ systems and some of the tissues composing them (epithelial, muscle, connective, nerve, glandular); a discussion of the gross functions of these systems and tissues with attention to the fact that certain systems function to service all cells of the body; integration of body functions

(a) Digestive system: mouth, oesophagus, stomach, small and large intestines, digestive glands (names of enzymes and their specific actions not required). Function: intake of food, extra cellular digestion of food to components that can be used by cells, transfer of end products to blood and lymph for distribution. Experiment to demonstrate the enzyme action of ptyalin or pepsin

(b) Circulatory system: heart, arteries, arterioles, capillaries, venules, veins. Noting that it is a closed system; that blood circulates; that arterial blood pressure is maintained; that no cell is very far from capillaries of this system (use living frog or fish to demonstrate). Block diagram of pulmonary and systemic circulation (names of arteries and veins not required for examination purposes); lymphatic system. Function — transport of needed materials, including secretions of endocrine glands to cells and of wastes away from cells

(c) Respiratory system; nasal passages, larynx, trachea, bronchi, bronchioles, lungs, alveoli, chest cavity, diaphragm, rib muscles, respiratory centre, and main respiratory nerves. Function: ventilation of lungs bringing fresh air close to capillaries where oxygen enters blood for distribution to all cells and carbon dioxide carried from cells leaves blood

(d) Elimination systems: kidney, glomerulus and capsule, tubules, ureter, bladder, urethra. Function: filtration of blood; tubule re-absorption of water and useful solutes; elimination of waste solutes; regulation of water and solute content of body fluid, i.e., fluid bathing cells

Elimination functions of sweat glands, respiratory system, digestive system; brief mention of function of sweat glands in regulation of body temperature and salt balance

(e) Muscular and skeletal system: muscles, bones. Tissues: muscle and connective tissue; bone and cartilage. Functions: movement, support, protection

(f) Reproductive systems
  (i) Male systems: structures; tissues (gonadal, glandular, muscular); functions
  (ii) Female systems: structures; tissues (gonadal, glandular, muscular, uterine epithelium); functions

(g) Coordinating system
  (i) Nervous system and sense organs — sense organ (eye, ear, taste, smell, temperature), sensory nerves, brain, spinal cord, motor nerves (Note that prepared dissections, rather than class dissections, should be used.)

  Tissues: nerves, connective

  Function: receiving information from environment and from all organs of the body and coordinating rapid response to conditions in environment and internal organs. Student dissection of a mammalian eye and a study of the function of its parts; relation of optic nerve and visual area of brain

  (ii) Endocrine system — complexly interrelated system of glands producing special substances — hormones — which are liberated into blood and carried to organs (target organs) on which they act. Hormones coordinate processes of metabolism, growth, reproduction, regulate the activity of organs which control water and salt content of body fluids. Names and locations of the endocrine glands with hormones produced, their target organs and their functions. Interrelations of nervous and endocrine coordinating systems

(iii) Steady State Control of the Whole Organism — chemical control of breathing rate and depth. Control of water balance, salt content, and glucose concentration of body fluids. Control of menstrual cycle in human female. (These control systems should be treated in sufficient detail that general principles of feedback systems will be made clear.)

3. Dissection and microscopic examination of one herbaceous dicotyledonous plant to show the following systems, and discussion of gross function of each system, showing that each system functions to service all the cells of the plant body. Discussion of examples of other dicotyledonous plants to show features not illustrated by examples of these:

   (a) Supporting system: temporary (collenchyma tissue), permanent (sclerenchyma tissue, secondary wood), turgor and cell wall

   (b) Anchoring system: roots and/or underground stems, diffuse and/or tap form of system, advantages of each, extent of root hair growth

   (c) Absorbing system: root hairs and osmosis;
      (i) water — water loss and osmotic values (transpiration)
      (ii) ions — accumulation and rejection of ions

   (d) Conducting system: water and minerals — path from root hair to xylem, xylem of root, stem, leaves; sugars, amino acids, etc. — from site of photosynthesis through phloem of leaves, stem, roots

   Note: no cell in the plant is far from conducting cells

   (e) Growth system: nature and location of the primary meristems; secondary growth regions (vascular and cork cambiums) in roots and stems

   (f) Gaseous exchange system; stomates and operation; intercellular air spaces; gaseous diffusion versus breathing; wet cell walls

(g) Photosynthetic system: favourable position of chlorophyll-bearing cells, each cell adjacent to an air space

(h) Food storage system: starch, fats, oils — energy in organic compounds

(i) Reproductive system: flower, carpel, ovule, egg, anther, pollen grain, sperm, pollination, fertilization, seed, fruit

(j) Coordinating system: auxins operating through growth regions in roots and stems, abnormal growth due to disease organisms and parasites; initiation of flowering stage triggered by photo-period and causing changes in the metabolism and growth pattern of the plant; effect of environmental factors on the seed development, germination, and growth

(k) Excretory system: waste accumulation in leaf, leaf fall; toxic substances exuded from roots

(l) Regulation of internal environment: plant starch — sugar balance and osmotic effects; transpiration and osmotic effects; water and salt balance; control of p^H, temperature

Unit IV. CLASSIFICATION OF ORGANISMS
(18 periods)

In this unit the purpose, principles, and methods of classification should lead to an appreciation of the natural groupings and the great variation in structure and function of organisms.

1. Brief history of systematics: Linnaean system; post-Darwin system
2. Discussion of the principles involved in classification of organisms; definition of a species as a group of essentially similar forms; meaning of genus, family, order, class, phylum, kingdom; complete classification of common conifers to species (e.g., scotch pine, red pine, white pine, spruce, etc.); classification of legumes to genus

(e.g., pea, bean, acacia, etc.); classification of the domestic cat to species; classification of beetles to order; identification of common conifers by use of a simple dichotomous key

3. Examination of specimens to determine
   (a) Characteristics of the vertebrate classes, Pisces, Amphibia, Reptilia, Aves, and Mammalia
   (b) Characteristics of the phylum Arthropoda
   (c) Characteristics of four classes of Arthropoda (Myriapoda, Crustacea, Insecta, Arachnida)
   (d) Characteristics of four orders of Insecta (Coleoptera, Diptera, Hymenoptera, Hemiptera)

4. Examination of specimens to determine
   (a) Characteristics of four phyla of algae (Cyanophyta, Chlorophyta, Phaeophyta, Rhodophyta)
   (b) Characteristics of fungi and the classes Phycomycetes, Ascomycetes and Basidiomycetes
   (c) Characteristics of lichens
   (d) Characteristics of the phylum Tracheophyta and the classes Filicineae, Gymnospermae and Angiospermae

5. New systematics based on genetic relationships, definition of biparental species as a population of interbreeding organisms.

Unit V. INTERDEPENDENCE OF ORGANISMS
(12 periods)

This unit deals with organisms as mechanisms driven by energy which is derived from the sun and often stored in energy-rich foods by green plants. As well as energy, other inter-relations lead to an appreciation of interdependence of organisms and their relation to the physical environment.

1. Photosynthetic activity of chlorophyll-bearing plants producing energy-rich foods, carbohydrates, fats, proteins; dependence of fungi, bacteria, herbivores, carnivores on energy stored in this food supply

2. Food chains and food webs; carbon cycle, nitrogen cycle; one way flow of useful energy; pyramids of number, biomass energy; communities of organisms; succession in communities; interaction of organisms and environment

3. Over-production of offspring; number of spores, eggs, seeds, larvae or nymphs; juveniles compared with number of adults in populations of insects, fish, trees, etc.; fluctuations in population density; natality versus mortality; biotic potential versus actual population

4. Discussion of closely interdependent organisms as parasites, saprophytes, symbionts, commensals and social organisms (the advantages derived by each organism from the association should be stressed). Two or three examples to illustrate each

5. Man as a dominant species; his dependence upon other species; his effect on his environment; finite sources of energy; infinite potential to reproduce; problem of population size

Unit VI. REPRODUCTION OF PLANTS AND ANIMALS (10 periods)

This unit describes the fundamental process providing the mechanism for continuance of life of each species by providing new individuals. Attention is to be focussed on the mechanism allowing for variations within populations and the importance of this for heredity and evolution.

1. Duplication of an individual organism by asexual or sexual reproduction. Asexual reproduction including the production of individuals whose inherited material (DNA) comes from a single parent with the chromosome number unchanged (vegetative reproduction) or with a reduction in the number of chromosomes by meiosis. In sexual reproduction the new individual develops from a zygote produced from the fusion of inherited material (DNA) contained in the gametes from two parents; sexual differentiation of gametes in many organisms

2. Meiosis, variation in allele composition in gametes (e.g., egg and sperm), syngamy (fertilization), zygote, significance of these processes in transmission of genes (DNA) from generation to generation, haploid, diploid, alternation of generations; reference to the existence of tetraploids and polyploids; sex chromosomes; sex determined by a specific group of genes

3. A general discussion of the start of life for an individual organism; cell enlargement producing growth; genetic control of these processes; importance of cell environment. Seed size and egg size in terms of stored energy for young organism. General discussion of the difference between plant and animal differentiation and growth. Relative importance of sexual and asexual reproduction in maintaining populations of plants and animals. Seed size and seed number as factors in maintaining plant population; egg size, egg number, and parental care as factors in maintaining animal population

Unit VII. HEREDITY, ENVIRONMENT, AND EVOLUTION (15 periods)

This unit involves a study of the effects of heredity and of environmental changes on plants and animals.

1. Darwin's theory of evolution based on evidence of fossils, plant and animal geography and comparative gross morphology

2. Variations in population of a species due to non-heritable environmental effects and due to heritable variation. Recent ideas of mutation (change in DNA) as the source of change in heredity. Selection of heritable variations due to environment and population pressure as a cause of evolution. Conservative and divergent action of selection. Genetic isolation and origin of species

3. Source and development of domestic plants and animals; human selection in plant and animal breeding